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THE JOURNAL
OF
THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

DEVOTED TO THE ADVANCEMENT OF ASTRONOMY AND ALLIED SCIENCES

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OF

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

VOL. XXV, No. 4 APRIL, 1931 WHOLE No. 203

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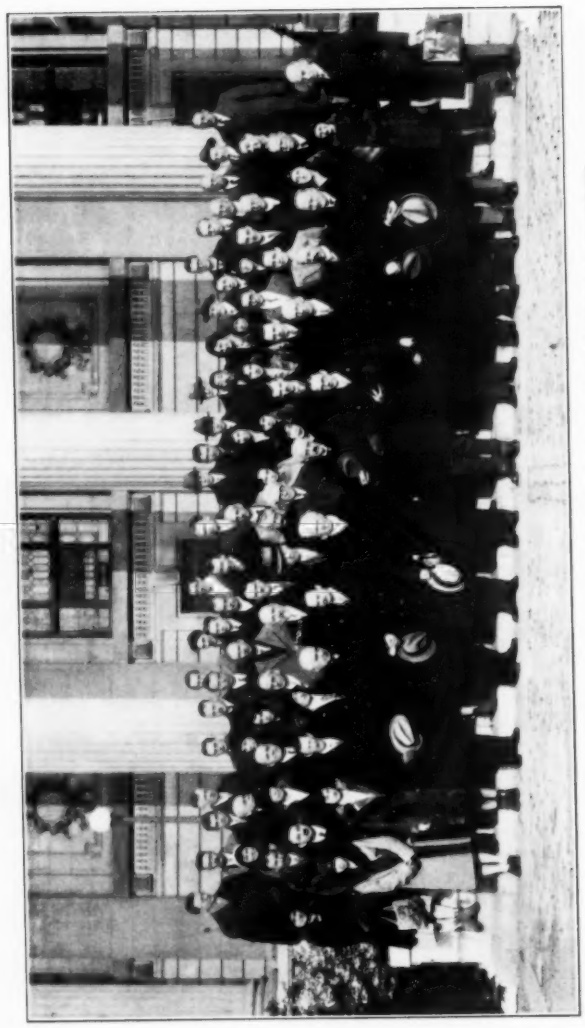
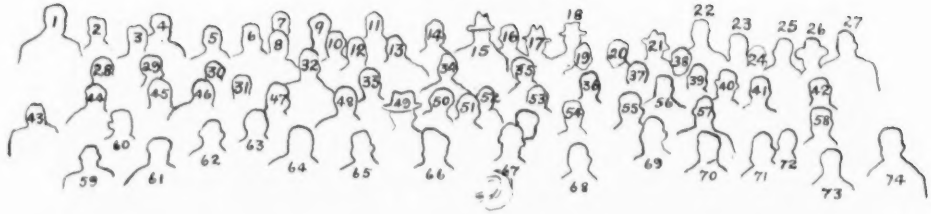
PLATE V



FORTY-FIFTH MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY,
New Haven, December 31, 1930 to January 3, 1931.

KEY TO PLATE V



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3. J. S. Hall
4. Turner
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6. Van Arnam
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THE FORTY-FIFTH MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY

By R. MELDRUM STEWART

(With Plate V)

THE forty-fifth meeting of the American Astronomical Society, on the invitation of Professor Frank Schlesinger, was held at Yale University, New Haven, Connecticut, December 31, 1930, to January 3, 1931.

In point of facilities and conveniences for a meeting of this kind, Yale University commends itself in every way, as will be attested equally by members who attended the previous meeting there a few years ago and those attending on the present occasion. To one visiting New Haven for the first time one of the most striking features is the extensive equipment in the way of University buildings, which are scattered in various groups over a comparatively large area of the city, evidently offering almost unparalleled educational and residential facilities for the students, the vast majority of whom live in residence. To a visitor from the supposedly frigid north another interesting circumstance was the transition from the comparatively mild Ottawa weather to decidedly wintry conditions, which persisted throughout the stay. One is given to understand, however, that this difference is not considered permanently characteristic of New Haven winters.

The sessions for papers were held in William L. Harkness Hall. Many of the visitors were very comfortably housed in one of the dormitories, otherwise vacant during the Christmas season, while

those who preferred found accommodation in near-by hotels. Meals were served during the meeting in the Faculty Club, where the Council also held its sessions.

On Thursday evening the society was favoured with an illustrated lecture by Dr. Weld Arnold on the U. S. Naval Observatory expedition to Niuafou (otherwise "Tin-Can") island to study the total solar eclipse of October 21, 1930. The lecturer's graphic description of the experiences and work of the party was much appreciated by the audience and served to recall the circumstances vividly to a number of his hearers who were actual members of the expedition. The description of the method of transferring mail to and from visiting steamers in floating cans propelled by swimmers, made necessary by the lack of landing facilities, and from which the island derives its name, was new and interesting to many of the listeners.

At the close of the Friday afternoon session the members proceeded to the observatory in cars kindly loaned for the purpose; incidentally, on this occasion the writer enjoyed his first ride in a "rumble seat". After an inspection of the observatory and instruments, the visitors were entertained at tea by Doctor and Mrs. Schlesinger. Among the exhibits which attracted the greatest attention, the one which was to many the most interesting was the coudé telescope, now being refitted for photo-electric work; aside from its astronomical interest, this also proved popular by reason of the splendid view of the surrounding country obtained from the top of the observing-room tower.

The necessary and usual relaxation was provided at the dinner on Friday evening at the Faculty Club, with President Brown as toastmaster. Unusually happy and appropriate speeches were forthcoming from Schlesinger, Dugan, Stebbins and Pickering, as well as the President; in all the usual wit and kindly vituperative badinage were not found lacking. Many expressions of satisfaction were privately heard over the recovery of Dr. Schlesinger, who had been under the surgeon's hands at the time of the previous meeting.

The Council met for the transaction of business on Wednesday evening and again on Friday and Saturday morning; the usual number of new members were elected; among other matters of

business were arrangements for the society's publications and for the 1932 meeting of the International Astronomical Union. Morning and afternoon sessions for the reading and discussion of papers were held on Thursday and Friday, and a morning session on Saturday. Without entering on a discussion of the papers on technical aspects of astronomy, mention might be made of the description of the astronomical section of the Franklin Institute Museum, Philadelphia. One of the main features of the projected installation is a Zeiss Planetarium, which is expected to be in operation by the end of the year. Mr. James Stokley, the author of the paper, formerly of Science Service, will be in charge. This will be the second planetarium in the United States, with others to follow. Why not one for Canada?

Thirty-eight papers were presented; the titles were as follows, in the order of presentation:

1. S. G. Barton: A note on least squares (lantern).
2. A. L. Loomis: A precision chronograph for the continuous comparison of several clocks.
3. E. W. Brown and Dirk Brouwer: Analysis of Shortt clock records made by the Loomis chronograph (lantern).
4. G. H. Draper: On the notion of time and space.
5. S. A. Korff (introduced by J. Q. Stewart): Contours of the D absorption lines (lantern).
6. Frank Schlesinger and Ida Barney: New reductions of astrographic places with the help of the recent Yale catalogues (lantern).
7. Frank Schlesinger and Ida Barney: Reduction of photographic plates of very large angular dimensions (lantern).
8. Lois T. Slocum: Some results from a study of the colour indices of faint stars in 5 selected areas in the Milky Way (lantern).
9. Cecilia H. Payne: Colour indices in Harvard standard regions (lantern).
10. Joel Stebbins: Colorimetry of stars and nebulae (lantern).
11. J. Q. Stewart and R. B. King: Resonance opacity and dark nebulosity (lantern).
12. James Stokley: The astronomical section of the Franklin Institute museum (lantern).
13. Otto Struve: A study of the helium lines in stellar spectra (lantern).
14. Joe Ueta (introduced by R. G. Aitken): Identification or non-identification of a comet and an asteroid.
15. R. W. Marriott: The United States Naval Observatory eclipse expedition to Niuafou (lantern).
16. J. H. Pitman: Times of first and fourth contact, eclipse of October 21, 1930 (lantern).

17. W. J. Fisher: Cycle, epoch and peculiarities of the recorded Leonid returns (lantern).
18. Alexander Vyssotsky: Further evidence as to the magnitude of Sirius B.
19. C. O. Lampland: Lowell photographic observations of Pluto in 1915, 1929 and 1930 (lantern).
20. S. B. Nicholson and N. U. Mayall: The orbit and mass of Pluto (lantern).
21. C. H. Smiley: Mathematical features of Pluto's orbit.
22. F. Slocum and C. L. Stearns: Method of observing Eros for position (lantern).
23. Margaret Harwood: The photographic light curve of Eros in 1930 (lantern).
24. Leon Campbell: Photometric light curve of Eros.
25. V. M. Slipher: Simple direct means of getting rapidly rough colour indices of stars (lantern).
26. P. M. Millman: Probable errors of objective prism radial velocities (lantern).
27. L. V. Robinson: Problems of Cepheid variation (lantern).
28. E. M. Lindsay (introduced by H. H. Plaskett): The behaviour of the hydrogen lines in stellar spectra (lantern).
29. W. B. Pearce (introduced by H. N. Russell): On the presence of SiH in sunspots.
30. R. S. Richardson: Evidence for the existence of SiF, AlO, AlH, and ZrO in sunspots.
31. H. N. Russell: Molecules in solar and stellar atmospheres (by title).
32. Charlotte E. Moore: Atomic lines in the sunpsot spectrum.
33. C. J. Krieger: A spectrophotometric study of Eta Aquilae.
34. W. W. Morgan: On ionized manganese in stellar spectra (lantern).
35. Piet Van de Kamp: Note on the distance to the galactic centre.
36. Sten Asklof: Determination of the definitive orbit of the comet 1917 I from photographic and visual observations separately (lantern).
37. S. G. Barton: The double stars in the San Fernando astrographic zone.
38. Otto Struve: On the origin of bright lines in spectra of B-type stars.

A SHORT SUMMARY OF OBSERVATIONS OF VENUS

(Made at East Longitude 174° 46′, South Latitude 36° 53′)

By James W. Alexandre

THE glorious blazing radiance of Venus has now disappeared from our evening sky for about three years, and since the October Journal of the Society mentions in its article on Venus that this beautiful scintillating celestial jewel is unfavourably placed for northern hemisphere observers, I have ventured to cherish the hope that my report of observations, made mainly in daylight and mostly with the naked eye, may be interesting to astronomical enthusiasts north of the equator.

I have been particularly fortunate in regard to the weather in the winter months which have been remarkably mild and fine, a fact which will be understood when I say that a tropical flowering shrub, the hibiscus, kept blooming nearly four months after the usual period.

After the greatest easterly elongation of Venus on September 12, our spring weather came with absolutely unprecedented violence, and up to date has been the most severe and tempestuous ever recorded, and under these circumstances I have had to make my observations with great difficulty and discomfort, often having to scan closely the occasional gaps in the racing clouds for a glimpse of Venus. Up to this period, that is, before our vernal equinox, however, I was able to observe the planet any time I chose in daylight as I soon attained proficiency in locating it. The meridian altitude gradually increased as the brightness increased, and on October 29, eleven days after greatest brilliancy, the planet's greatest southerly declination was 27° 17′ 12″.1. For the latitude of Auckland this amounts to a meridian altitude of 80° 24′, which of course calls for an uncomfortable attitude of the head in observing. I shall, however, only give the observations which have any interest attached to them.

The planet was in superior conjunction with the sun on February 6, 1930, and first became visible to the naked eye eight weeks afterwards, at 5.30 p.m. mean time on April 3.

A very unusual sight in these latitudes was a conjunction of Venus and Mercury at 9.30 p.m. on April 27. Mercury is exceedingly hard to see as the haze at sunset is usually very luminous and dense.

The next interesting spectacle was the sight of Venus and Jupiter on the nights of the 17th-18th and 19th of May. The conjunction took place at 5.30 a.m. on the 18th. It was noteworthy how Venus became brighter as Jupiter became smaller and redder after they passed each other. Jupiter's diminution in magnitude and increase in ruddiness made it look like the tail-light of a rapidly receding railway train.

My first sight of Venus with the naked eye in daylight before sunset, was at 3.40 p.m. mean time on July 14, when the proportion of the illuminated portion to the whole disc, k, was 0.74.

I was observing the planet at 2.03 p.m. on July 16, when I saw a very brilliant meteor appear about 2° to the west of Venus and travel over a 10° path toward the zenith. By finding the exact position of the planet at that instant from the *Nautical Almanac*, it was easy to determine the approximate path of the meteor, which began at 153°, +12° and ended at 151°, +2°.

The evenings of the 27th, 28th and 29th of July were notable for the presence in the western sky of the young moon, Mercury and Venus. As I mentioned before, this is unusual on account of the elusiveness of Mercury.

I had an opportunity to use the 6-inch equatorial refractor of the Auckland University College and I examined Venus at 2 p.m. on July 29. On this occasion the illuminated portion k was 0.69. I used all the powers that were available but was quite unable to detect any shading or variation in colour on the planet. I was not surprised, as I know that far better eyes and instruments than mine have been used with the same results. I repeated the telescopic examination twice when k was 0.68 and 0.54 at 7.30 p.m. on August 1, and 6.30 p.m. on September 2, respectively. No worthwhile observations could be made on account of the low altitude of Venus at these hours and the secondary spectrum of the objective.

I was favoured with another daylight meteor at 11.47 a.m. on September 28 when I was pointing out the planet Venus to my family. I was watching the planet at this time when I saw a very brilliant white meteor appear about one and a half times the

moon's diameter to the south of Venus. It described a very curved path with the extremities almost horizontal and the convex portion toward the eastern horizon. Its approximate path was begun at 228°, −22° 30′ and ended at 227°, −32° 30′. In passing I may state that there are more daylight meteors than hundreds of people realize. I have seen a fair number but it is just about impossible to determine their paths as there are no relatively permanent sky or landmarks. By this I mean a planet whose exact place at the moment of observation can readily be found, when it is simply a matter of laying off the meteor's track on a star map.

The very moist state of the atmosphere at this time tended to make Venus a most inspiring sight on account of the irradiation, and as the times of greatest brilliancy and greatest southerly declination occurred within eleven days of each other, the planet presented a magnificent spectacle for quite a long period each night round about this period.

On November 8 I started a regular series of observations, night by night, with a view of determining how close to the sun the planet could be seen. In spite of difficult weather conditions, I was able to see Venus with the naked eye for six more days. Up to this later date it was interesting to note the rapid travel of the planet through the constellation Scorpio, the reference point that I took for the purposes of comparison being the very conspicuous red star Antares.

Venus was last seen with the naked eye at 6.33 p.m. mean time on November 14, when the angular distance from the sun was 12.9°. No doubt the personal equation affects this observation to a small amount as my eyes are somewhat short-sighted, and a keen eyed person might have seen Venus for several days longer.

I then resorted to the use of prismatic 8x binoculars for further searching, and at 6.12 p.m. mean time on November 17 the fine crescent was a lovely sight, the prolongation of the cusps being very conspicuous.

I looked to see if the earthshine effect reported by some observers was visible at 6.37 p.m. mean time on November 18, but failed to see it. This non-success I consider was due to the low magnification used.

Bad weather prevented an observation being made on November 19.

Under extremely difficult weather conditions I was able to see Venus for the last time at 5.55 p.m. mean time on November 20. There had been several severe rain-storms about that time, with racing clouds over the western sky, and it was due to the fact that the sun was providentially screened by one that I was enabled to scan closely the fan of rays showing behind the cloud's edge, and for a few seconds I could see the thread-like crescent of Venus. The angular distance at this time was calculated to be 5° 7′. If there is any member of the Society who has followed the planet closer to the time of inferior conjunction, working with the same methods, I would like to hear from him.

At various times on November 21, I searched the sun's rays but without success. Inferior conjunction occurred the following day on November 22.

8 Ashton Rd., Mt. Eden,
Auckland, New Zealand.
26 December, 1930.

MAKING THE STARS STAND STILL*

By James Stokley

I want you to come with me on a journey—an imaginary journey. Suppose that we are out under the night sky. Not the sort of sky that we see from our great cities here in the east, where the haze and dust and bright lights obscure all but the brighter stars and planets—but the night sky that you see from such places as the high plateau of northern Arizona, or the mountains of California. The extraordinarily clear air, and the darkness, reveal stars that we city-dwellers have ordinarily to take on faith. The Milky Way shines brilliantly overhead and disappears behind the distant trees on the horizon.

Now stretch your imagination a little further. Let us suppose that this marvellous display above our heads is completely under our control. By some miraculous means we are able to check the rotation of the earth, and to make the stars stand still. Or, we can speed up their motions. Just as the hero of H. G. Wells's famous story, "The Time Machine", was able to travel forwards and backwards in time as well as space, we can set the heavens ahead or behind. If we wish, we can see them as they will be thousands of years from now. Or else we can go the other direction, and reproduce the starry sky as it was on that first Christmas night, thousands of years ago. We see the stars and planets speed through the sky, their motions accelerated so that the normal motions of a year take place before our eyes in as little as seven seconds. Then, suppose we can shift this magnificent night sky to show the stars as they appear from any part of the earth. The Great Dipper settles in the north, finally disappearing completely from view. To take its place, the famed Southern Cross rises in the south. Alpha Centauri, nearest of all the stars, shines high in the sky.

*A Radio Talk presented Friday, December 26, 1930, under the auspices of Science Service through stations of the Columbia Broadcasting System. Mr. Stokley, formerly of the staff of Science Service, is now Associate Director of the Franklin Institute Museum, Philadelphia.—Editor.

Perhaps you think that such a miracle as this can never be. Quite right, we cannot do it in the real sky, but we can, and do, reproduce it in such a realistic fashion that all of these things that I have descrbed take place above our heads. Within a year, we hope, there will be erected in the city of Philadelphia a specimen of one of the most ingenious products of optical engineering—a Zeiss Planetarium. The miracles I described to you will be shown regularly at the public demonstrations of this instrument, just as they are now being shown in about twenty European cities that have installed them. The one in Philadelphia, the second to be erected outside of continental Europe, will be the main feature of the Astronomical Section of the Franklin Institute Museum, now being organized as a memorial to one of Philadelphia's greatest citizens—Benjamin Franklin. Mr. Samuel S. Fels, already widely known for his philanthropies, has presented the Planetarium to us.

The Planetarium is the product of the great optical works of Carl Zeiss, in Jena, Germany, and is the invention of Dr. Bauersfeld, of that firm. It is really a glorified stereopticon, or magic lantern. Thirty-two lenses, sixteen in each of two large bulbs at the ends of the instrument, project images of all the naked-eye stars on a white hemispherical dome, seventy-five feet in diameter, forming the ceiling of the room. Each lens projects the picture of part of the sky, so that they cover it completely, with no gaps, and no overlapping. In a cylindrical part, at the centre, are projectors for the sun, the moon, and all the naked-eye planets. Other projectors throw on the dome the names of the constellations, some of the imagnary lines used by the astronomer to find his way around the heavens, and the face of a speedometer device that shows the year that is being represented. A number of motors turn the instrument and move the individual projectors. All are controlled from a switchboard operated by the lecturer at one side of the chamber.

The first Planetarium was made for the great Deutsches Museum, in Munich, Germany, and it proved such an admirable device for teaching the knowledge of the heavens that a number of other German cities wanted one also. Dr. Bauersfeld was rather surprised by the popularity of the device so he made some improvements, and now the latest type of planetarium is in operation in

sixteen other cities in Germany, including Berlin, Hamburg, Dresden, Leipsic and Jena. Then, one was erected in Vienna, another in Rome, then in Moscow, Stockholm and Milan. Last spring one opened in Chicago, the first outside of Europe. Philadelphia will be the next, and, if the experience of Europe is repeated, and I feel sure it will be, other American cities will follow these two leaders.

And now let me try to give you some idea of what you will see when you come to the Franklin Institute Museum, a few years from now. Philadelphia's magnificent Parkway begins at the City Hall, directly opposite which is Broad Street Station, and extends out to Fairmount Park, the largest city park in the United States. At the park end is the new Philadelphia Art Museum. About half a mile out from City Hall is Logan Circle. On the east is the Cathedral, on the south the Academy of Natural Sciences and the site for a great new music centre, on the north of the new Public Library, and on the west is a site of four and a half acres on which will soon rise the Benjamin Franklin Memorial and Franklin Institute Museum.

The Franklin Institute was founded in 1824 by two young men, to honour the memory of Franklin. These two were W. H. Keating, later professor of chemistry in the University of Pennsylvania, and Samuel Vaughan Merrick, who was to become the first president of the Pennsylvania Railroad. The following year there was started a journal which has continued without interruption to the present day. The lectures before the Institute by leading men of science have been a prominent feature from the start, and at these lectures many important scientific announcements have first been made. The Franklin Medal, awarded annually, is universally ranked as one of the highest awards that can come to a scientist. In 1924, when the Institute's centenary was celebrated, among those in attendance were six winners of the Nobel Prize, as well as two others to whom the prize has been given since.

Though some of these lectures are necessarily of a technical nature, this is not always the case. Of particular general interest is the series presented every Christmas week for the benefit of young people. These are similar to the famous Christmas Lectures, given each year in London at the Royal Institution.

These lectures are given in the same building on Seventh Street that the Institute has occupied for a century. Naturally, in this time the building has become rather antiquated and the new building will enable us to present such lectures to larger audiences with far better facilities. But the entire Museum will be a display to the public showing the development of technical science, and its latest achievements. As in the Deutsches Museum, in Munich, many of the exhibits will be arranged so that the public can themselves operate them. Historic machinery will be seen in actual operation. The very apparatus with which famous scientists made important discoveries will be on display, and replicas will be so arranged that the visitor can himself, in many cases, repeat these classic experiments. The director of the entire Museum is Dr. Howard McClenahan, secretary of the Franklin Institute. Associated with him are three Associate Directors. Dr. James Barnes, now professor of physics at Bryn Mawr College, is to have charge of the section of physics. The section of engineering will have Mr. Charles E. Bonine, prominent Philadelphia engineer, at its head. I shall have charge of the section of astronomy, which, besides the Planetarium, will include an observatory for the use of the public, and several rooms of astronomical exhibits.

Because the planetarium instrument is now ready for us in Germany, and will be delivered as soon as we give the word, the astronomical section, in the southeast corner of the building, will be completed first. We hope to have this section open to the public by December, 1931, and the entire Museum in full operation a year later.

As you walk out the Parkway from City Hall, let us say in the summer of 1933, you will soon come to Logan Circle. In front of you will be the Museum, a marble building in English Renaissance style. You cross the circle and enter the building, and find yourself in a huge rotunda. In the centre is a monumental statue of Franklin, and in niches around the wall are various mementoes of this great man. In rooms branching off from this rotunda you see all sorts of interesting exhibits.

But the planetarium lecture is about to start, so you will postpone your inspection of these other parts of the Museum. Turning to the left, and descending a flight of steps, you come to the entrance

of the Fels Planetarium. You enter and sit in one of the chairs that encircle the great projector in the centre. Above is the white dome, around the horizon is a reproduction of the Philadelphia skyline, as it appears from the roof of the building. The audience of several hundred people is in place and the lecturer takes his post at the switchboard. As he speaks, the lights are gradually dimmed, so that your eyes will become accustomed to the darkness. In a few minutes the room is completely dark. Then the miracle happens. The building seems suddenly to have melted away, and you seem to be out in the open under the stars. An involuntary "A-a-a-h" escapes the audience. Then the celestial panorama is unfolded. The stars move across the sky, just as they do in nature, but hundreds of times as fast. A faint glow appears in the east, and then the sun rises. But it is a sun that is intentionally dimmed, so that you can see the stars among which it passes in its annual path.

The sun in its diurnal motion (due to the earth's rotation) reaches the meridian, and stops. Like Joshua, the planetarium operator can stop the sun in its course, and show the effect that would be obtained if the earth always presented the same face to the sun, as the moon does to the earth. This gives us an event that never happens—eternal noon, and, as the other motions continue, the sun descends in the south, to the place it occupies at the beginning of winter. Now you can see why winters are cold in the northern hemisphere. Being so low in the sky, the sun shines at a low angle on the earth, and the same amount of heat is spread over a larger area. Then the sun comes north again, and as it does so we see the constellations through which it passes. At its lowest winter position it was in the group of Sagittarius, the archer. Then it moves eastward into the next-door constellation of Aquarius, the water carrier, and into Pisces, the fishes. It is now the beginning of spring. The sun climbs still higher, and soon is in the constellation of Gemini, the twins, in the position it occupies in June at the beginning of summer. But this is next summer! In the few minutes that you have been in the planetarium there has passed in front of you a celestial change that ordinarily takes a year.

Then, perhaps, the rotation of the earth is resumed. The sun

sets in the west, and we stop to study the stars. Would you like to see the stars visible from South America? Very well, we can take a flight to the south pole, and on the way the Southern Cross, the Centaur, the good ship Argo, and all the other southern constellations appear. Or perhaps you would like to see some of these groups without going south. All right. You can still be accommodated. Because of the slow swing of the earth's axis, that the astronomer calls precession, there is a regular change in the heavens taking 25,800 years to complete. As a result, our present pole-star is only the temporary occupant of that place of honour. Thousands of years ago the star we now call alpha Draconis, or Thuban, was the pole-star. By the year 14,000, Vega, the brilliant star in Lyra, the lyre, will be near the pole. And, by that time, the same precessional change will bring the Southern Cross well above our horizon, visible as far north as Quebec. All this can be shown with the planetarium.

But I could continue here for hours, telling you of what the planetarium can do. And even when I had finished, you would not have a much better idea of its real effect than if I had not spoken. Like the real night sky, it must be seen to be appreciated. So let me close with a cordial invitation to all of you to visit the Franklin Institute Museum, after it is opened to the public in a year or so.

ERRORS IN TRIGONOMETRIC PARALLAXES*

THERE has long been a feeling that the probable errors of measured quantities are in reality higher than that given by theory from the internal agreement of the measures. Luyten, in *Proceedings National Academy of Sciences* for July, 1930, seeks to make an experimental test of this by intercomparing the results of parallax determinations at the different observatories. The number of stars in common is now felt to be large enough to make this worth while and all results available September, 1929, were used. McCormick observatory is selected as the standard to which the others are referred because that observatory has the most in common with the other observatories.

Allegheny has the next largest number and a preliminary comparison of these two observatories shows systematic differences in right ascension, possibly in declination, and also with respect to magnitude and type. The difference in right ascension had been discussed by Van Maanen in 1928 and suspected much earlier by other workers. (A recent paper by Lee on negative parallaxes suggests that in reducing from relative to absolute values account should be taken of the different distances of the comparison stars with respect to galactic longitude as well as galactic latitude.) All such systematic differences, however, are small compared to the accidental errors and so he uses the actual differences between any two observatories without making any corrections thereto. Such tabulated differences with proper weights give a series of equations connecting the different observatories, which when solved by least squares yield the following systematic corrections to the arbitrary standard, McCormick. The probable errors of the series, as Luyten finds them, are appended:

	Corrections	p.e.
	$''$	$''$
Allegheny	$+.0016$	$\pm.0095$
Greenwich	$-.0012$	$\pm.0126$

*Seminar Talk at D.A.O.

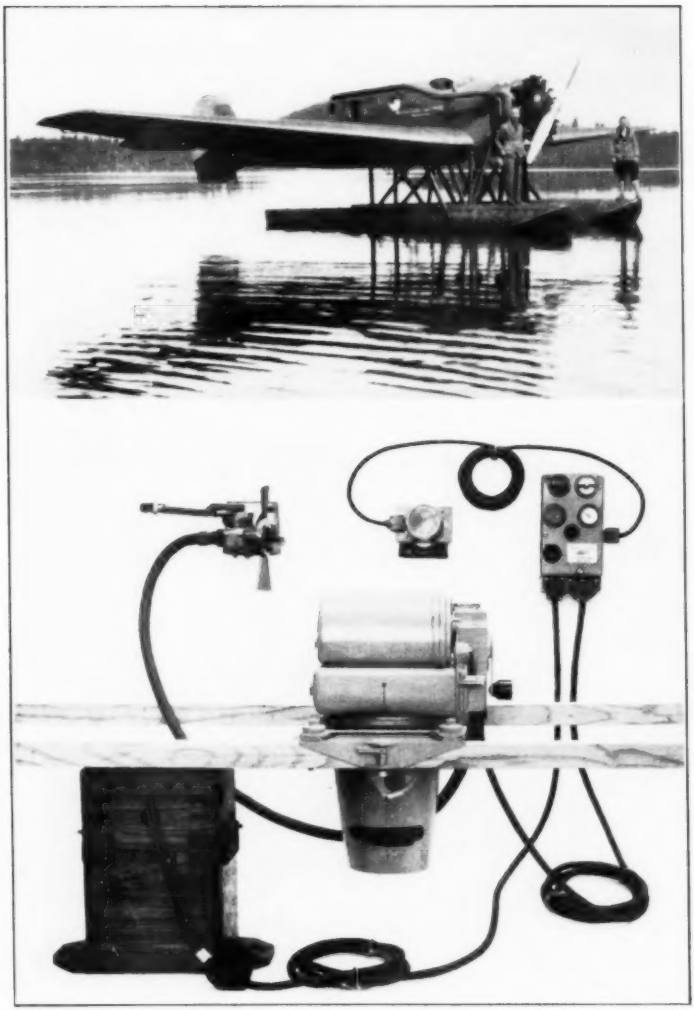
McCormick	.0000	±.0111
Sproul	−.0048	±.0144
Mount Wilson	−.0056	±.0162
Yale (southern)	−.0044	±.0155
Yerkes	−.0006	±.0141

Apart from Yale, which has too few stars to consider as rigorously determined, and Mount Wilson, in which the p.e. seems much too large, being almost double Van Maanen's published values, the others are only about 20 per cent. on the average in excess of the errors as published. The investigation, therefore is proof that the various observatories have carefully eliminated the main sources of error and one can feel some measure of confidence in statistical discussions where parallax determinations are used.

W. E. H.

A PHOTO-TOPOGRAPHICAL PICTURE WITH GRID SUPERIMPOSED
to Illustrate the Method of Plotting a Lake.

PLATE VII



Above.—A JUNKERS SEA PLANE, the Photographic Ship of the Western Canada Airways, Limited.

Below.—AUTOMATIC AERIAL CAMERA designed for the British Air Service.

PLATE VIII

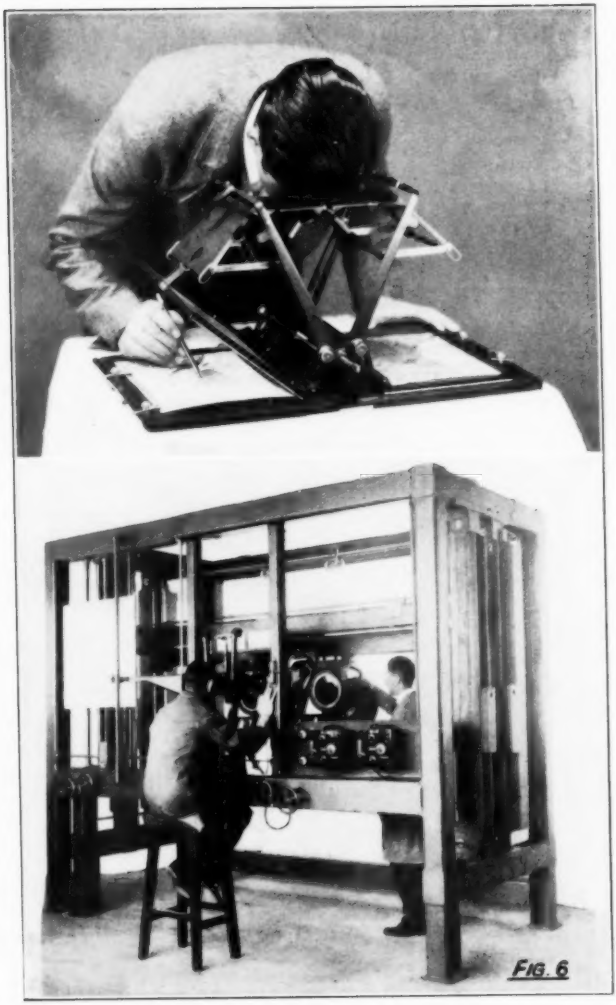
FAIRCHILD SEA PLANE used in Photography in British Columbia by the Royal Canadian Air Force.

A TYPICAL MAPPING PHOTOGRAPH.

It shows a winding river in a valley about a quarter of a mile wide. On either side of the river some older channels partly filled in are seen. This information is of interest to the geologist and the drainage engineer. If this photo is viewed with its mate under a stereoscope the valley sides are found to be well timbered but steep. If the forest engineer has made sample cruises in the valley, he will be able to estimate the amount of timber in the area covered by the photo and also be able to consider the best way to log the timber.

Journal of the Royal Astronomical Society of Canada, 1931.

PLATE X

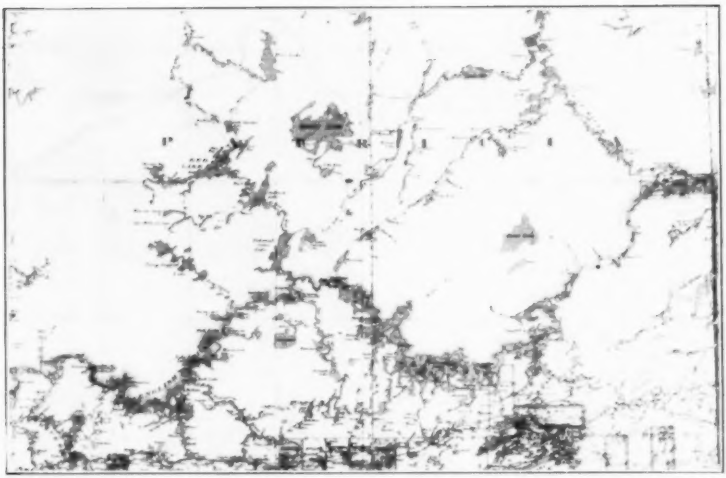


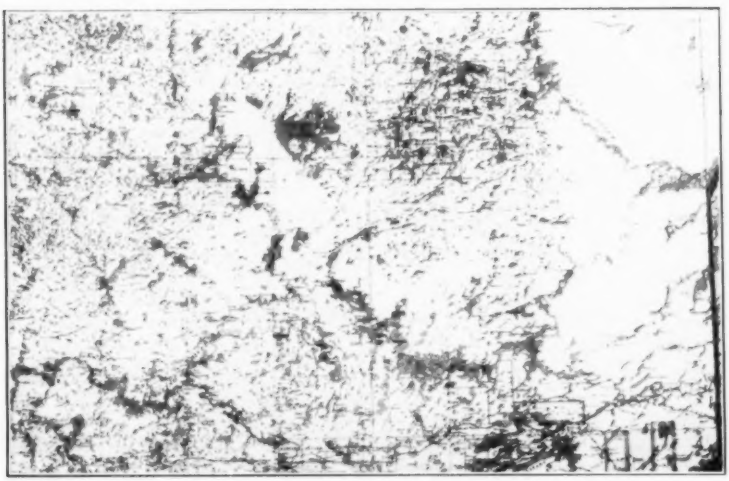
Above.—A FOLDING STEREOSCOPE with Grid Plates used in Contouring; designed for Field Use by Barr and Stroud, London, England.

Below.—THE BARR AND STROUD PLATTER, known as the "Big Bertha" of Photographing Mapping Instruments. The map is made by the manipulation of certain gadgets when a pair of overlapping photos are properly placed in this machine.

Journal of the Royal Astronomical Society of Canada. 1931.

PLATE XI





THE SPEED OF MAPPING BY THE AERIAL METHOD is illustrated by the above cuts which are from two maps covering the same part of Ontario. The upper one was issued in 1924 and contained all existing information, which had taken many years to obtain. The lower one was published three years later. (The area covered is approximately 28,000 square miles.)

Journal of the Royal Astronomical Society of Canada, 1931.

SURVEYING FROM THE AIR

By N. C. Stewart
Vice-President, Victoria Centre, R.A.S.C.

(With Plates VI-XI)

ALTHOUGH "Surveying from the Air" is the popular title for the subject of the present article, it is in fact a misnomer, for we cannot actually survey from the air, but with the aerial photographs and a ground survey to control them we can make a map. The accuracy of the map depends on the adequacy of the ground control.

Many branches of scientific knowledge are required to complete an aerial survey, but the two principal ones involve (1) the older methods of surveying based on the use of common surveying instruments and trigonometry and (2) the use of photography which, in comparison to the first, is a new science.

History of Surveying

The science of surveying, like that of astronomy, dates back to very ancient times. Probably the earliest historical reference is shown on a stone now in the Museum at Palermo. Records of measurements made in 3000 B.C. are depicted on this stone. History shows that in the early Egyptian civilization the fields along the Nile had to be surveyed each year, due to the spring floods washing away the work of the previous year. The exactitude of the measurements of the sides of the pyramids and the levelling of the foundations speak well for the quality of the work in those ancient times.

As we come down through the ages more records are left showing improvements in methods and in instruments. The Greeks and Romans had fair systems for the delimitation of land boundaries and made rather good maps. Our old British mariners compiled charts that were very accurate. Some of the charts of our own coast, made by the navigators of the 16th century, are really

remarkable. Certain geographic positions established by Capt. Cook and Capt. George Vancouver are still being used.

During the latter part of the 18th century and the first part of the 19th, considerable advancement was made in the application of new mathematical theories to the science, and improvements were made in surveying instruments by the addition of the telescope. During the 19th century measuring instruments of great precision were devised. Precise surveys were made early in the last century for the purpose, among other things, of finding out the exact dimensions of the earth, and the shape of the earth as defined by Clarke in 1866 is still used as the basis for geodetic calculations.

History of Photography

The science of photography has developed in recent times. In 1727, Schulze, a German physician, discovered that a pasty mixture of chalk and a solution of silver nitrate darkened when exposed to sunlight. He produced dark images of stencils. In 1790 Wedgwood obtained some photographic results on paper treated with silver nitrate. In 1835 Talbot took the first photograph as we know it, on paper prepared with silver salts and placed in a camera, but in 1841 he perfected the process, and this is probably the best date to give for the actual beginning of photography. In 1848 a Frenchman introduced a film on glass, carrying sensitized salts, which was the forerunner of the photographic plates of today.

Laussedat, a French scientist and surveyor, perceived that photographs might be used as an aid to mapping. Even before the advent of photography an attempt had been made to produce maps by making perspective drawings in the field and then constructing the map from these drawings. The photograph provided a more accurate and complete perspective. Laussedat recognized this and began his research in photo-topography, the results of which he announced to the Academy of Sciences in Paris in 1859.

The late Dr. Deville, Surveyor General of Dominion Lands, introduced and perfected the method of photo-topography in Canada. The instruments he devised specially for the work are still in use, almost in their original form, and the book which he

prepared is still the classic on the subject. The first Canadian photo-topographic survey was made in 1886 in the Rocky Mountains adjacent to the Canadian Pacific Railway. Since that time the method of plotting the detail from the photographs has been considerably simplified by the discovery of graphical methods, and a good portion of these improvements is due to two British Columbia surveyors, Mr. McCaw and Mr. A. J. Campbell.

In Europe the stereoscopic principle was applied to ground photographs. This called for pairs of photographs being taken from the ends of a short base and which, on being viewed in a stereoscope, would bring out the relief. Intricate machines were made for plotting directly from the negatives. This method proved successful for intensive large scale maps, but such maps are not in very great demand in this country. (See Plate VI).

Photographs carefully taken in panoramas with an ordinary camera are also used in exploratory mapping and a considerable amount of this work has been done in the interior of British Columbia. The accuracy obtained is, of course, much lower than the two methods already described.

Photo-topography has reached such a high state of accuracy that it is doubtful if any other method of topographical mapping excels it in this regard. However, the method of ground photo-topography is only suitable for mountainous areas where sufficient camera stations can be obtained from which to photograph the country, each part of which must be photographed from two widely separated points. The transportation of the field equipment from one station to another is very laborious. The method fails altogether in flattish country.

Aerial Photography

In 1858 another Frenchman, M. Nadir, took a photograph of Paris from a balloon, and since then many similar attempts were made but none of these were of any great value. In 1912, shortly after the airplane became practicable, the Royal Flying Corps commenced to take photographs from the air. The progress of aerial photography up to the outbreak of the Great War was very slow. But during the war great strides were made, so much so

that airplanes were called the eyes of the army, not only on account of the vision of the observers but also because of the accurate information supplied by their cameras. Many steps were necessary in the evolution of the camera to bring it up to the marvellous camera of today and a great many of these steps were made during the war. It was early realized that the requirements of a camera suitable for aerial work were:

(1) Simplicity.
(2) Compactness.
(3) Lightness in weight.

The first cameras embodying these essentials were hand-held plate cameras with a lens usually of 8-inch focal length, focussed at infinity and with a focal plane shutter. A simple sight of cross wires in a brass tube was provided. The camera was not automatic and was not suitable for taking mapping photographs.

The necessity for vertical photographs resulted in an attempt to fix the camera rigidly on the outside of the fuselage. This was also found impracticable owing to the difficulty of operation. A semi-automatic plate camera was then designed using a magazine holding 18 plates. Two movements were necessary to change the plate and take the picture. This camera was not mechanically perfect, hence it failed at times.

The L-type plate camera was next brought out. It could be worked either by hand or automatically, the only attention necessary being the depressing of a release lever to actually take the photograph. The power was supplied by an air screw on the side of the plane and transmitted by a flexible shaft to the camera inside the fuselage. This was a very good camera which did excellent work.

After the war there came a change in camera design, the ideal camera being one designed to fulfil the requirements of the surveyor who called for a photograph sharp enough for the detail necessary in his methods, and which would cover a sufficient area at each exposure to keep the cost within reason. The tendency of designers towards film cameras resulted in the invention by the Fairchild Aerial Survey Inc. of a camera that is mechanically perfect. It is light, comparatively small in bulk, and absolutely automatic in operation, so that continuous exposures may be made at fixed

intervals for obtaining definite overlaps. It is provided with levels so that it can be pointed nearly vertically downward and is mounted so as to be free from the vibration of the aircraft. It has a "between-the-lens" shutter and is adapted to take lenses of various focal lengths. The film is held flat at the instant of exposure. A red warning light is provided in front of the pilot which flashes on a couple of seconds before the shutter is released so that he can level his ship. The size of the photographs is 7 × 9 inches, each magazine containing 65 feet of film which permits of a hundred or more exposures being taken before changing the magazine. As the changing of the magazine requires but a few seconds, the operator can make the change without varying the overlap required for mapping photographs. Many other clever devices are incorporated in this camera. It may be mounted for either vertical or oblique pictures. Filters are provided to correct for the unevenness of the light rays on the sensitized film and the film is specially designed for this particular work, being a hyper-sensitized panchromatic film. The Fairchild camera is a mechanical marvel which works under the most trying conditions, but its cost in this country is almost prohibitive. (See Plate VII).

A new camera has recently been designed for the British Air Service. It appears to be a very good instrument of small design and produced at a comparatively low cost. The mapping lenses are of focal lengths 5 and 10 inches and the film exposed on a 5×5 inches surface. Definition is good in the negatives, which will therefore stand enlarging.

A camera much in use by the Geological Survey of the United States is what is known as a multi-lens camera. It has four lenses, one points vertically downward, two pointing at fixed oblique angles on either side of the vertical, and the other pointing either forward or backward also at an oblique angle. The object of the many lenses is to take in a large field. The oblique photographs are transformed in a transforming camera to the plane of the vertical photograph and so can be used in the same way as if taken vertically. The Bagley Camera, as this multi-lens camera is called, should prove practicable even in British Columbia where the valuable lands are in the valley bottoms, which would be covered by the

vertical photographs, while the less valuable portions on the mountain sides would be covered by the oblique.

Other multi-lens cameras have been designed, and it is understood that the Fairchilds have under way the construction of a nine-lens camera, the whole idea being to cover a greater field at each exposure.

Airplanes

So much publicity is given to aviation that everyone has a fair knowledge of aircraft, but it should be noted that few models of aircraft are suitable for photographic work. The chief requirements needed for this work are plenty of power so that the ship may climb quickly to high altitudes, large cruising radius, good visibility for the pilot so that he can fly his lines straight, and a comfortable place for the camera man. Specially designed aircraft for survey work are now being manufactured. These are twin-engined, with the cockpit in front between the engine mounts, so designed that the camera man is in front and below the pilot. (See Plates VII, VIII).

Developments in Canada since the War

As already stated, great advancement was made in air photography during the war. Every scheme with the slightest chance of success was tried out. A large personnel was trained in the science and in the interpretation of air-photographs, and when the war ended many minds became active in trying to find ways to adapt their knowledge to peace time pursuits. The British Government, at the close of the war, presented to the Canadian Air Board about $5,000,000 worth of planes and equipment. This stimulated interest in aviation in Canada. The late Dr. Deville, who was a member of the first Air Board, saw the possibilities of utilizing air photographs for mapping the unknown parts of the east and a start was made in 1921, when about 280 square miles were photographed. In the following year the Topographical Survey under Dr. Deville devised a graphical method of plotting from oblique photographs, and since then each year has seen a great increase in the areas

photographed and mapped. Mapping from oblique photographs is only practicable in more or less flat countries and for small-scale exploratory maps.

Oblique Method

In the oblique method a camera, usually of 8-inch focal length, is placed in the nose of a flying boat. The photographs are taken at an elevation of from 4,000 to 5,000 feet, in sets of three, one straight ahead, one 60° left and the third 60° to right, these sets being taken about two miles apart. The depression of the camera axis of 18 to 20 degrees places the apparent horizon line 3/10 to 7/10 of an inch below the top of the picture. The parallel flight lines are usually in the east-west direction, so taken to minimize the effects of the sun, and are spaced approximately six miles apart. Cross flights are made at the ends and middle of the area covered by the parallel flights to act as a photographic tie in the event of insufficient ground control being obtained. It is the duty of the surveyor-navigator to direct the pilot over each flight line, which he does by referring to sketches made on the previous flight and by his memory of the features of the ground. Compasses are found to be of little value in a plane. A navigating sight has been perfected in the laboratories of the Topographical Survey of Canada, which enables the navigator to make sketches approximately to scale, so as to locate points to direct him on the next flight.

Simplified plotting schemes have been invented for the oblique method so that now small scale maps covering large areas are turned out in a very short time. The plots from the photographs are controlled by surveys made on the ground, carried out by land surveyors in the field, preferably after the photographs have been printed and supplied them. (See Plate IX).

The Vertical Method

For larger scale mapping, the vertical method was developed. In 1927 a successful aerial topographical survey was made near the city of Quebec, where the relief is fairly great, although not to be

compared with the relief found in British Columbia. In 1928 a start was made on a test survey in B.C. when 4000 sq. miles were photographed by the Royal Canadian Air Force. In the vertical method automatic film cameras, focal length 8 inches to 12 inches, are used. The flying height is up to 15,000 feet and sometimes greater. Above 17,000 feet oxygen is required. The flights are usually in the east-west direction with occasional cross flights to act as checks. The camera is pointed vertically downward and the photographs are taken so as to lap over 50 per cent. in the forward direction. The next parallel flight is made to overlap the former one by 20 per cent. to 60 per cent. so that all the area is completely covered. The forward overlap is necessary in plotting and to give the stereoscopic effect which brings out the relief. The time between exposures varies from 20 to 30 seconds. In order to determine the proper time a camera sight has been constructed. This consists of a lens which projects the image of the terrain on a ground glass upon which are drawn two parallel lines so spaced as to conform with the predetermined percentage of overlap. With this instrument level the time taken by the passage of some object on the ground between these lines is observed with a stop watch, and is the time of the required interval between exposures. It needs to be frequently checked on each flight line to correct for the uncertainty of the wind's influence on the ground speed of the plane and the difference in scale due to difference in altitude of the terrain.

The lap in the forward direction is comparatively simple to obtain, but it is decidedly difficult to direct the flights so as to get just sufficient side overlap and not to leave gaps between the flights. It is said that only 5 per cent. of trained airmen develop the knack to become good photographic pilots. This difficulty adds greatly to the costs of mapping from the air, and this was one of the reasons for the design of the Bagley multi-lensed camera.

If the country photographed was absolutely flat, the plane flown at a uniform height, and the axis of the camera truly vertical, the plotting of the map from the photographs would be very simple, for each photograph would be true to scale and of the same scale as the adjoining photographs, but these three essentials never occur together. Usually none exist, so that methods had to be devised

to lessen the inaccuracy in scale due to relief, unequal altitudes and tilt.

The layman, in considering air photographs for mapping, usually thinks of mounting them together by cutting out portions that fit more or less closely, but as soon as he tries to do this, especially with photographs taken in a country of high relief, he finds that it cannot be done. The scales vary so much that this scheme is impracticable. Beautiful mosaics are made, nevertheless, but only after an actual plot of the flights have been made, when the scale of the individual photographs is obtained and the prints reduced photographically to common scale. Even then it requires great skill and patience to join the prints or portions thereof together. In a recent photographic operation in British Columbia, in connection with a resources survey of 10,000 square miles in the valleys of the Peace and its tributary the Parsnip River, over 21,000 vertical air photographs were obtained and the information contained in all these photographs was plotted within four months after the close of the field work. The success of an undertaking of such magnitude depended a great deal on the simplicity of the methods of plotting which have been devised. The method used is called the Radial Line Method, which is based on the assumption that angular distances between objects on the photograph, *measured from the centre*, are true and equal to the same angles measured on the ground. This assumption, although not quite correct, is sufficiently accurate for practicable purposes if the tilt is not too great, and provided sufficient control is obtained. On an aerial survey it is the duty of the surveyor or engineer to obtain by ground surveys a sufficiently extensive control to limit the errors that develop in the plots made from the photographs to the scale of the map to be produced. That is, no feature on the manuscript map should be misplaced by a scaleable distance. The topographical Survey of Canada which produces aerial maps at a two-mile-to-one-inch scale, requires an accuracy of one in five thousand for their ground control surveys.

Control may be obtained in various ways. In the settled portions of the east, where roads are numerous, accurate traverses are made, and in the more remote regions, of which maps are made from oblique photographs, less accurate stadia traverses are made,

and the traverses may be controlled by astronomic observation for latitude and longitude. In British Columbia accurate control is obtained by triangulation. The whole province is being covered by a net-work of triangles. In our primary triangulation, the sides of the triangles are from five to forty miles long. These large triangles are broken down into a secondary system and from the secondary stations rays or directions are taken to prominent objects such as junctions of streams, islands, hilltops, cutbanks, houses, etc., points easily identifiable in the photograph. Usually the ground surveys are made the year following that in which the photographs were taken so that the surveyor has the prints with him in the field. He will then be able to locate and identify prominent points in the photographs with the aid of a field stereoscope. If the survey is carried on before the area is photographed, ground signals may be made which will appear in the photographs, or in country of diversified features he may make sketches which will serve to identify the points tied to, when the photographs are obtained. It is found that flights of vertical photographs over flattish country should be controlled at least every eight or ten miles, if the error of the plots is to be limited to reasonable amounts. In mountainous or hilly country the control points should be much closer. The surveyor first places on his manuscript maps all the control points obtained in the field, then he compares the plots of a flight between two control points with that shown on his manuscript, and is able to find the proper reduction for the flight strip to reduce it to the scale of the map. All the information required on the map, including form lines which are placed on the photographs under a stereoscope, is added to the plot of the flight strips, and then the reduction is made with a pantograph or by photography. (See Plate X).

Instruments

Soon after the study of overlapping vertical photographs commenced, it was found that the common overlap was stereoscopic. Improvements were made in the design of the stereoscopes so as to take in various sizes of photographs and to increase their efficiency in many ways. The principle of stereoscopic measurements

was studied for aerial views chiefly in Europe, but also in the United States. In Germany Hugershoff designed the Aerocartograph to plot directly from transparencies taken with the camera pointed in any direction. In Switzerland, Wild adapted his Autograph for aerial views. In Italy, Nistri invented his Photocartograph which, to quote from the literature describing it, "determines the position of two photographic plates by methods purely mechanical and without calculation; it allows of an automatic and continuous tracing of both detail and contours without the complication of any calculation." In the United States a firm in Philadelphia has patented a method of surveying, using stereoscopic measuring instruments.

Barr and Stroud in Great Britain advertise a tilt finder and plotter with which the detail on aerial photographs may be plotted. They also make a Stereogoniometer embodying the invention of Mr. Henry Fourcade of South Africa, with which the data regarding aerial photos such as tilt, orientation, etc., can be obtained by its use without the necessity of having control points except in one pair of overlapping photographs. That is, if in a series of overlapping photographs one pair of consecutive photographs have the necessary control points, the data regarding all the photographs in the series may be obtaned by the use of this instrument. (See Plate X).

Progress in Canada

The first real attempt at aerial surveying in Canada was made, as already stated, in 1921, when an area near Ottawa of 280 sq. miles was photographed. Last season (1929) 32,780 sq. miles were photographed vertically and 50,225 sq. miles were covered by oblique photography, giving a grand total of 83,005 sq. miles. If you remember that the area of Great Britain is 87,464 sq. miles, you may mentally picture what was done in Canada in aerial photography in the year 1929.

My records do not include the year 1923, but with this exception there has been photographed in Canada up to the present time (1929) 346,660 sq. miles; this is equal to over 90 per cent. of the Province of British Columbia, or 9 per cent. of the whole of Canada.

340,000 air photographs are filed in the office of the Topographical Survey of Canada in Ottawa. (Prints may be obtained by any one at moderate cost.)

Other Uses of Aerial Photographs

The value of this great library of photographs will be recognized when their many uses become more widely known. Aerial photographs aid the engineer in the design of protection works along rivers, in the location of railroads, transmission lines, dams and wharves.

In forestry, the boundaries of the forest types are obtained. Air-photographs aid the forester in planning his work for they direct his attention, without loss of time or effort, to those parts of the country where timber will be found and to eliminate from consideration vast stretches of barren and fire-denuded lands which would otherwise have to be investigated.

Air photographs are being used as an aid in geology, mining, and prospecting. Rocky areas are easily located on the photographs, and hence show the prospector where rock exposures may be found. A geologist familiar with the stereoscope can often tell the nature of the rock from a study of the photographs.

For administrative purposes in cities, mosaic maps are made.

The use of aerial photographs, especially obliques and mosaics for publicity purposes, is self-evident and generally speaking air photographs are particularly useful in the study of a country difficult of access and wooded areas where vision on the ground is restricted. In more settled areas town planning schemes are aided by a study of the views.

In the Resources Survey already mentioned it was found that the photographs provided the delimitation of the ground cover, the extent of the agricultural land, the areas covered by rivers, lakes and barren lands, a fair understanding of the probable location of future roads, trails, railroads, etc. The photographs helped in the study of the water power resources and gave a proper understanding of the relief of the country sufficient for the few available geologists to collate the results of their field examinations.

Conclusion

Although many improvements are being made in the method of mapping from air photographs, it is conceded by all governments that the method has passed the experimental stage. One of its greatest benefits is the time factor, for the method is extremely rapid. On a good photographic day one plane will cover over five hundred square miles with vertical mapping photographs. The method permits of more thorough mapping, for the draughtsman, when provided with the overlapping photographs, has the country in miniature always before him. Any desired accuracy may be obtained for the accuracy of the plots depends on the amount and quality of the ground control. (See Plate XI).

In the last few years the airplane has added greatly to the knowledge of our own country and is aiding in the development of our hinterland. The aerial maps convey much of this new information to our administrators as well as the public and so are an important factor in opening up our vast unknown areas. It is safe to predict that in a very few years there will be no blank spaces in the map of Canada.

REVIEW OF PUBLICATIONS

Spherical Astronomy, by W. M. Smart. 413 pp., 5½×8½ inches. Cambridge University Press. Price, 21 shillings net. 1931.

This book fills a long felt want in the English language, and will make a good text book on the subject. In addition to the usual subjects, included in such a treatise,—spherical co-ordinates, aberration, precession, nutation, etc.,—there are very good chapters on the use of the photographic plate in determining star positions, heliographic co-ordinates, spectroscopic and visual binaries. These are rightly included as part of the subject. The book is copiously illustrated with very well conceived diagrams and is clearly written. Another feature that makes the book attractive is the fact that all the examples are taken from the present year's almanac. There are fifteen chapters which have the following titles: 1. Spherical Trigonometry, 2. The Celestial Sphere, 3. Refraction, 4. The Meridian Circle, 5. Planetary Motions, 6. Time, 7. Planetary Phenomena and Heliographic Co-ordinates, 8. Aberration, 9. Parallax, 10. Precession and Nutation, 11. The Proper Motions of the Stars, 12. Astronomical Photography, 13. Determination of Position at Sea, 14. Binary Star Orbits, 15. Occultations and Eclipses. At the end of each chapter are a goodly number of exercises.

R. K. Y.

Astrophysik, auf atomtheoretischer Grundlage, von S. Rosseland. Pages, vi, 252, 5½×8½ in., with 25 ill. Berlin: Julius Springer, 1931. Price, bound, RM 21.20.

This is volume XII of a series of monographs on the Structure of Matter. The author is a professor in the University of Oslo, Norway, and director of the observatory there. His object was, he states, to supply to physicists a condensed introduction to the problems of astrophysics, and at the same time to fill a gap which seemed to exist in astronomical literature.

It comprises six divisions: (1) Astrophysical facts established

by observation; (2) Physical foundations for the problems relating to the interior of stars; (3) Hydrodynamics of stars; (4) Energetics and the history of stellar evolution; (5) Physics of stellar atmospheres; (6) Problems of the gaseous nebulae.

On account of the moderate size of the book only a brief treatment is given to the various portions of the wide subject, but the author endeavours to apply the results of the latest researches. Thus he gives a comprehensive summary of present-day astrophysics. In the treatment of the various questions which arise mathematical analysis is freely used, frequently by means of vectors. Some of the subjects discussed are, the transmission of energy within a star, the theory of stellar coefficients of absorption, rotating stars, the pulsation theory, problems of the chromosphere, the problem of bright lines in stellar spectra, interstellar space—empty or full.

The typography of the book is excellent, but it is unfortunate that the limited sale of such works causes the price to be rather high. C. A. C.

NEWS AND COMMENTS

The forty-sixth meeting of the American Astronomical Society, on the invitation of Professor Harlan True Stetson, will be held at the Perkins Observatory, Ohio Wesleyan University, Delaware, Ohio, on September 7, 8 and 9. Those attending will have the opportunity of inspecting the observatory and the large reflecting telescope, recently erected.

An iron-nickel meteorite, fourteen feet long and weighing about 75 tons, was discovered half way between Lake Nyasa and Lake Tanganyika, by W. H. Nott, a Johannesburg surveyor. This is considered to be the largest yet discovered. The largest one previously known is that near Grootfontein, South West Africa. It is almost rectangular in shape, of dimensions nine by ten feet and from two and a half to almost four feet thick. The upper surface is almost horizontal. When first found only a small portion protruded above the ground. Its weight is estimated at not less than fifty tons. It contains 17.42 per cent. nickel and 81.29 per cent iron. Farther south in South West Africa, in the limestone desert just east of Gibeon, is a whole valley peppered with iron meteorites, each of about 500 pounds, of which forty or fifty have been dug up.

In connection with the Total Solar Eclipse of August 31, 1932, the line of totality of which cuts down through Quebec and Maine, Miss K. Williams, Assistant Secretary, The Royal Astronomical Society, Burlington House, London, W. 1, England, is receiving applications from those who wish to join either of two tours which are being arranged to leave England about July 22 and August 12, 1932. On the earlier tour it is planned to visit Quebec, Montreal, Ottawa (Dominion Observatory), Winnipeg, Banff, Lake Louise, Victoria (Dominion Astrophysical Observatory), Seattle, San Francisco (Berkeley University and Lick Observatory), Chicago (Adler Planetarium and Yerkes Observatory), Niagara Falls, Boston, and on the later tour, Quebec, Montreal, Ottawa, Toronto,

Niagara Falls, New York, Boston. A conference of the International Astronomical Union will be held at Cambridge, Mass., soon after the Eclipse. As accommodation must be booked a long time ahead, those who desire to join one of the tours should apply to Miss Williams as early as possible. Possibly some members of the Royal Astronomical Society of Canada may wish to avail themselves of this splendid opportunity of joining a real astronomical tour in the company of many astronomers from the old country. Further particulars may be obtained from Miss Williams, or nearer at hand from Director R. Meldrum Stewart, Dominion Observatory, Ottawa.

Dr. Willem de Sitter, director of the Observatory at Leiden, Holland, who, as stated in last month's JOURNAL, was awarded the Gold Medal of the Royal Astronomical Society, has also been awarded the Catherine Wolfe Bruce Gold Medal for distinguished services to astronomy, by the Astronomical Society of the Pacific.

REDEL.

NOTES AND QUERIES

Communications are invited, especially from amateurs. The Editor will try to secure answers to queries.

Eleven Thousand Miles per Second

For some time the astronomers at the Mount Wilson Observatory have been discovering objects with apparent velocities of over a thousand miles per second, and very recently the highest value of all has been announced, namely 11,000 miles per second. It is a considerable number of years since V. M. Slipher, director of the Lowell Observatory, initiated these discoveries of enormous velocities and the statement made by him that the objects exhibiting these velocities are practically all moving away from the solar system is continually being substantiated. The faint nebula giving this record velocity was discovered by William H. Christie, who received his astronomical training at the Dominion observatories at Victoria and Ottawa. The spectrum of the nebula was photographed by Milton L. Humason, who had already taken a number of similar photographs. From the apparent velocity it was deduced that the distance of this "island universe" was 120,000,000 light years. As has been remarked before, astronomers consider these tremendous velocities to be only apparent, not real, the true explanation being in the curvature of space as postulated by Einstein. It is only in immensely distant bodies that the effect of the curvature of space can be detected.

Full Moon and Hot Nights

The present writer has ordinarily associated a full moon with a cool night. With a brilliant full moon the sky is free from cloud and one naturally expects strong radiation from the earth and hence a cool air, especially in a desert country. However, this does not always seem to be in accordance with observation, as the following quotation from "Letters of Gertrude Bell" shows. This letter is dated at Bagdad, July 6, 1917. The middle of the eclipse of the moon referred to occurred at about 12.37 a.m., Bagdad time, July 5.

I don't know whether it is a scientific truth but it's undoubtedly in accordance with facts—full moon nights are far the hottest and the stillest. Two nights ago. . . .I went to bed helplessly and fell asleep at once on my roof. I hadn't been asleep long when I woke up to find the Great Bear staring me in the face. I lie looking north. It was very strange to see the Great Bear shining so brilliantly in the full moon of Ramadhan and while I wondered half asleep what had happened I realized that the whole world was dark, and turning round saw the last limb of the moon disappearing in a total eclipse. So I lay watching it, a wonderful sight, the disc just visible, a dull and angry copper colour. In the bazaar a few hundred yards away everyone was drumming with sticks on anything that lay handy, to scare away the devil which hid the moon, and indeed they ultimately succeeded, for after a long, long time the upper limb of the moon re-appeared and the devil drew slowly downwards, angry still with deep red tongue, and wreaths projecting from his copper coloured body and before I had time to sleep again the Ramadhan moon had once more extinguished the shining of the Bear.

PROBLEMS FOR THE ASTRONOMER

The astronomer is called on to solve difficult problems of various sorts. He may have to make observations requiring the use of very delicate instruments and demanding skill acquired only by long experience; or perhaps he has to apply mathematical methods to determine just what his observations reveal; or, again, he has to try to understand what some person, learned or unlearned, has written. The present writer receives a considerable number of communications containing questions or theories which indicate a strange attitude of mind.

A few weeks ago, by appointment, a young man with bright brown eyes, having a Scottish name but speaking with a decided foreign accent, called to discuss some fundamental physical questions. He showed peculiar freedom in his use of physical terms, and as there seemed no likelihood of understanding what he really had in his mind, as he shifted his ground continually, he was asked to commit his views to writing, as it was hoped that would clarify them. In due time a document was received. Perhaps readers of the JOURNAL may be interested in reading over the following extract from it. What does it all mean?

PROOF BY LIGHT THAT TIME AND SPACE ARE CAUSED BY MOTION

Light travels at 186,000 miles per second, 186,000 miles of space equal one

second of time, and one second of time equals 186,000 miles. Should we change the value of either space, or time, the change would take place in motion. This proves that they are inseparable, and that time and space are one, and that they are caused by motion, and that motion is caused by time and space. For instance, subtract time from space, or space from time, equal 0, time plus space equals 186,000 miles a second, which is motion, subtract time and space from motion equals 0, or motion from time and space equals 0. Now the sum or time, or time and space, equal the difference between the two, which is 186,000 miles per second, which is light or motion. The fact that light is the difference between time and space is proof that it does not travel.

The difference between time and space is light and darkness. Space is instantaneous but changeable. It is the difference between one thing, and another that is space, and time.

Gravity is the difference between time and space, which is motion. It is its own bend, for instance, the weight of light is its own curvature, or bend, we might say it weighs 186,000 miles per second. Or one second time, resistance to 186,000 miles. Yet it is not time or space, it is the difference between light and darkness. Time is the curvature of space, and space is the curvature of time. This is what renders them instantaneous. Light can be weighed as its curvature is its weight. Gravity is the tension of time on space, or the tension of space on time, according to energy.

If all things were the same there would be no space or time. It is the difference between things that gives us this impression. This is why they are instantaneous, because they do not exist, only to the human mind.

"Verstaendliche Wissenschaft"—Easily Understood Science

The Editor hopes he may be pardoned for printing the following translation of a review which appeared in the well-known Swiss newspaper, *Neue Zürcher Zeitung*, Sunday, November 30, 1930.

The collection under this title, published by Julius Springer (Berlin), has been enriched recently by three small volumes, in which there is an attempt to give a description of nature and of popular science in the manner of Alexander von Humboldt. To do this is a splendid but difficult problem. The amount of all the knowledge of the present day is so stupendous that nobody should undertake such a task—even if he is able to write as the Lord himself—unless he has an instinct which tells him what is really worthy and indispensable out of the whole mass of the riches of science.

Enviably sharp is this instinct developed in Clarence Augustus Chant, Professor of Astrophysics in the University of Toronto, to whom we owe his book "The Wonderful Universe" (in a good translation by Kruse). If the intention of the author was to arouse in the young people a thirst for knowledge to stir their imagination in a lively and most pleasing fashion, and to give them

at the same time a fundamental and realistic representation of the majesty, the mystery, and the unimaginable sublimity of the cosmical structure and its operations, then his intention has been fulfilled in a particularly beautiful way.

The style of the book is easy, the language is simple and condensed; and in this excursion into the sky-world, in which the author consistently refrains from indulging in mathematics, this method of treatment, which is the author's chief desire, is maintained with a display of great resourcefulness and certainty of aim. The terrestrial point of view, from which the author always starts and to which he regularly returns, is well supported by the originally-conceived pictures. The numerous exquisitely beautiful photographs, the majority of which were produced at the Mount Wilson Observatory, add to the brilliance of the intellectual presentation.

Eros Elongated in Shape

The tiny asteroid Eros, after approaching the earth at the end of January to a distance of 16,000,000 miles, has moved away from our vicinity again, but many photographs of the body among the surrounding stars will supply months of labour for the astronomer before a new measurement of the distance from the sun to the earth will be available. For many years it has been known that the light from Eros varies with a period of 5 days 16 hours, and it was suspected that the body was irregular in shape, with different portions of its surface having different reflecting powers. It is now reported that two astronomers at the Union Observatory, Johannesburg, South Africa, viewing the little planet through their 26-inch refracting telescope have clearly detected its ellipsoidal shape. They estimate the length to be 25 to 29 miles and the average width to be 8 to 10 miles.

C. A. C.

MEETINGS OF THE SOCIETY

At Toronto

December 2, 1930—A regular meeting was held in the Physics Building of the University of Toronto, at 8 p.m., Mr. J. R. Collins in the chair.

Rev. C. G. Martin, Major, Saskatchewan, was elected a member.

Moved by Mr. E. J. A. Kennedy, seconded by Mr. A. F. Hunter, that Drs. R. K. Young, L. Gilchrist, and W. M. Wunder report at the next meeting regarding nominations for elections of officers for the coming year.

Prof. H. R. Kingston, Ph.D., University of Western Ontario, London, President of the Society, gave a lecture, "A Month on the Moon."

When apportioning the amount of popularity given to the two most familiar objects in the sky, the sun and the moon, perhaps the greater proportion would be credited to the moon, for many reasons, sentimental and otherwise, which were humourously described. In these modern times, many farmers still invoke the aid of the moon, believing that it has some effect upon the growth of crops and that certain phases are opportune to planting.

The moon's phases were illustrated and described, also those of the earth and moon. It is perhaps not generally realized that to an observer on that face of the moon constantly turned towards us, the earth would always remain approximately in the same position in the sky, at the same time revolving upon its axis and exhibiting similar phases as the moon does from the earth.

Some splendid photographs of certain areas of the moon, taken at the Mt. Wilson Observatory, were shown. These are undoubtedly the finest ever taken, showing extremely fine detail, presenting to the view a wild and desolate landscape, and sufficient reason that a "Month on the Moon" would at least supply more thrills than food for philosophic thought.

The evening's constellation study, "Andromeda," was taken by Mr. Fred Troyer, who gave an able description of this group with various details of interesting objects.

December 16, 1930—A regular meeting was held at 8 p.m. Mr. J. R. Collins in the chair.

There were seven nominations for membership; on this occasion it was decided to dispense with the usual two weeks notice and the following were therefore elected:

James W. Alexandre, 8 Ashton Road, Mt. Eden, Auckland, New Zealand.
R. A. McIntosh, 23 Hollywood Ave., Epsom, Auckland, New Zealand.
Wm. W. Jaudis, 915 Milwaukee Ave., Racine, Wis.
Chas. W. Elmer, 14 Clark St., Brooklyn, N.Y.
Miss Nora Moore, 22 Prince Arthur Ave., Toronto.
Miss Jean E. Browne, 410 Sherbourne St., Toronto.
Dr. E. S. Jeffrey, 1004 Medical Arts Bldg., 170 St. George St., Toronto.

The constellation study was "Taurus", and Mr. E. J. A. Kennedy's description of the group was very interesting.

Rev. D. B. Marsh, D.Sc., Hon. President of the Hamilton Centre, took as his subject, "Our Galaxy and others Beyond." The lecturer traced the evolution of practical astronomy, dividing it into three distinct periods, namely,—naked-eye observations, the small telescope era, and the present age of huge instruments. Theoretical astronomy has advanced from the anthropocentric age, with man the centre of all; through the geocentric, with the earth as the centre of revolution; to the present heliocentric theory. The speaker described our own galaxy, its position in reference to others, and the distribution and distances of spiral nebulae in space.

At the close of the meeting the following were nominated and elected unanimously as officers of the Toronto Centre for 1931—

Honorary President, Sir Frederick Stupart
Chairman, R. A. Gray, B.A.
Vice-Chairman, A. R. Hassard, B.C.L.
Secretary, E. J. A. Kennedy
Treasurer, H. L. Rogers
Recorder, S. C. Brown
Curator, R. S. Duncan
Assistant Curator, Fred L. Troyer
Programme Committee, J. R. Collins, L. Gilchrist, R. A. Gray, E. J. A. Kennedy
Auditors, Dr. J. B. Fraser, Mr. A. R. Hassard.

January 27, 1931.—A regular meeting was held in the Physics Building of the University at 8 p.m. Mr. R. A. Gray in the chair.

Dr. W. M. Wunder was unanimously elected Treasurer, in place of Mr. H. L. Rogers, resigned.

Mr. S. C. Brown described Orion and the neighbouring constellations. Prof. R. K. Young addressed the meeting on Star Clusters and recent investigations with reference to their bearing on Stellar Evolution. The history of the clusters began with Herschel, and the great majority of clusters were discovered in his time. Clusters are divided into two classes, globular and galactic, which are distinguished, the one from the other, by their characteristics and distribution. About 100 globular and 250 galactic clusters are known. The galactic clusters contain few stars, are almost always found near the galactic plane and are rarely over four kiloparsecs distant. They are about evenly distributed in all galactic longitudes. The globular star clusters are distinguished by their approximately spherical form, large number of stars, and central condensation. They also tend to lie near the galaxy but there is a central region of avoidance, and they are most numerous at one particular longitude. Their distances range up to 50 kiloparsecs.

A study of the globular clusters leads to the belief that they outline by their

distribution the general size and form of the galactic system, with a total length of approximately 70,000 parsecs and a thickness of 10,000 to 15,000 parsecs.

The galactic system seems too large to be a simple spiral nebula such as seen in the sky in great numbers, but may consist of a flattened aggregation of spirals and star clouds in one huge flattened system. The centre of this system is in the direction of Sagittarius, about 16 parsecs distant. The system of stars seen with the naked eye are part of a local cloud surrounding the sun.

February 10.—A regular meeting was held in the Physics Building of the University of Toronto at 8 p.m. Mr. R. A. Gray in the chair. Eleven were elected to membership:—

Chas. A. Ellison, 33 Thorncliffe Avenue, Toronto.
Dugald Hepburn, 41 Wineva Avenue, Toronto.
Wm. Mayberry, Nanton Crescent, Toronto.
Mrs. H. S. Saunders, 7 Neville Park Blvd., Toronto.
Miss Grizilda Bovaird, Fort Erie, Ont.
Ovide Cadotte, 11½ Girouard St., St. Hyacinthe, Quebec.
Louis Francke, 1301 West Tenth St., North Little Rock, Ark.
Chas. Weatherbee, M.D., Twin Falls, Idaho.
Stuart L. O'Byrne, 501 Pacific Avenue, Webster Groves, Mo.
Geo. A. Davis, Jr., 314 M. & T. Bldg., Buffalo.
S. P. Skinner, 189 East Main St., Westfield, N.Y.

Under "Reports" Mr. J. R. Collins referred to information from Harvard on the appearance, position and rotation of the planetoid Eros; and also spoke for Mr. D. J. Howell who reported having observed the planet Venus through a haze, and distinguished the crescent form, on February 4 and 6.

Mr. M. S. Groh gave the constellation talk, speaking principally of Canis Major and Sirius. Mr. W. E. W. Jackson spoke on the variability of Eros, and Prof. Chant mentioned having seen a sun-pillar.

The chairman then called on Prof. Lachlan Gilchrist for his lecture on "Recent Geophysical Investigations in Mineralized Regions". Dr. Gilchrist spoke of his regret that Mr. A. H. Miller, of Ottawa, who had been with him in the investigations, was unable to be present, and proceeded to give an account of the results of electrical measurements of the conductivity of the earth in the neighbourhood of several deposits of minerals.

The conductivities of pyrite and pyrrhotite were much less than that of the surrounding materials and these deposits were readily delineated by the field measurements. The conductivity of lignite as obtained by laboratory measurements was only four or five times that of the surrounding materials. The results of the field measurements showed that the depth of overburden could be determined with a fair degree of accuracy in many places. The conductivity of chromite was in general lower than that of the surrounding dunite which was much affected by the presence of water as these materials had a lower conductivity than water. While the results of the measurements gave a general indication of the presence of the chromite deposit it would appear that the presence of water made it very

difficult to obtain definiteness of delineation by the electrical methods which were used in the investigation. The various methods were illustrated by experiments. Prof. Gilchrist then answered questions on the practical value of the results of their investigations, and after expressions of appreciation by the chairman of the lecture and well prepared experiments, the meeting was adjourned.

February 24.—A regular meeting was held in the Physics Building of the University of Toronto at 8 p.m. Mr. R. A. Gray in the chair. There were four elections to membership:—

Rev. Gilbert Lord Wilson, 342 Madison Avenue, Pasadena, Cal.
Irving Kunz, 622 Queen Avenue, Hoquiam, Washington, D.C.
George Hillyard, Supt. Power Plants for International Nickel Co., Nairn Centre.
Hugh H. Beach, University of Alberta, Edmonton, Alta.

Mr. J. R. Collins described the constellation Gemini, its position and some of its chief objects.

Mr. John A. Marsh, President of the Hamilton Centre, addressed the meeting on "Telescopes for Amateurs, and how to use them". The telescope must be regarded as the most important of astronomical instruments, without which the spectroscope, camera, etc., would be much less effective. The first instrument, made early in the 17th century, marked the beginning of modern astronomy, and the progress made in this science since then can be properly ascribed to the development of the telescope. For about 150 years after its inception, the optical parts were very imperfect, due to spherical and chromatic aberration, but the discovery by Dolland of a combination of crown and flint glass greatly minimised these defects. Many amateurs now make their own instruments, confining their efforts largely to the reflecting type, which is more economical, and simpler in construction than the refractor. A comparison of the two types would show that whilst the reflector is perhaps superior when observing nebulae, star clusters, and for photographic work, and suffers least from chromatic defects, the refractor will require less attention and will stand comparatively rougher usage.

The construction of the refractor including the proper alignment of optical parts, mounting and stands, was described, also the care and attention necessary to the preservation of the instrument.

The speaker demonstrated a splendid example of his own work in manufacturing telescopes, a three-inch refractor, which with the exception of the lenses and eyepieces, had been constructed in his own workshop, and brought to Toronto for this occasion.

Appreciation of Mr. Marsh's lecture and for the time and care necessary in its preparation was expressed by Dr. C. A. Chant and Mr. J. R. Collins.

S. C. Brown, *Recorder.*

At London

January 9, 1931—The regular monthly meeting was held in the Conference Room of the London Life Building. The president, Mr. E. H. McKone, was in the chair.

There were six elections to membership:

Miss H. Chapman, 383 Grosvenor St., London
Dr. J. R. Howitt, Ontario Hospital, Woodstock
Miss E. McMechan, 364 King St., London
Miss N. North, 328 St. George St., London
Dr. S. P. Reynolds, 45 Gerrard St., London
Mr. F. Radway, 373 Hamilton Road, London.

The usual observation period from the roof of the London Life Building was replaced, on account of poor star visibility, by a short period of theoretical star identification, conducted by Mr. T. C. Benson; the constellation Orion was studied. Miss N. Morris gave short and interesting reviews of two books by William Tyler Olcott, "Star Lore of all Ages" and "Sun Lore of all Ages." This was followed by a demonstration of the spectroscope, by Mr. F. H. Coates, who discussed briefly the various types of invisible rays at the upper and lower end of a spectrum.

A lecture on "The Milky Way and Beyond" was given by Dr. H. R. Kingston, who prefaced his lecture with a few remarks on the coming opposition of Eros. The lecture was illustrated throughout by lantern slides. The speaker emphasized the shape and size of the Milky Way, along with the various types of nebulae which occupy the region beyond the Milky Way. A detailed account of Dr. Kingston's lecture has already appeared in the JOURNAL for December 1930, page 452.

G. R. MAGEE,
Sec'y-Treas

AT HAMILTON

December 9, 1930.—The annual business meeting of the Hamilton Centre was held in the Public Library Lecture Hall and despite other attractions there was a goodly attendance.

Several announcements of interest were made and the Hamilton Centre took great pleasure in welcoming Prof. Wm. Findlay of McMaster University to the meeting. Prof. Findlay extended to the centre the courtesies of the science departments of McMaster University and expressed his pleasure at being associated with the Hamilton body.

It was moved by Mr. Hugh Roger and seconded by Dr. Gordon M. Jackson that the slate as drawn up by the nominating committee be adopted and that the following officers be elected for 1931, which motion carried, the officials being as follows:—*Honorary President*, Rev. Dr. D. B. Marsh, Norwich, Ont.; *President*, J. A. Marsh; *Vice-Presidents*, W. S. Mallory, Rev. John Samuel, T. H. Wingham; *Sec.-Treas.*, Miss A. B. Marsh; *Recorder*, Miss J. I. Jackson; *Librarian and Curator*, Hugh Roger; *Council*, Prof. Wm. Findlay, Dr. Gordon M. Jackson, Miss Winnifred Parker, Miss E. J. Reynolds, W. T. Goddard, Chas. E. Bull, Dr. W. R. Jaffrey, W. J. Hocking, W. G. Milne, Robert Wynne, C. F. Marshall.

Mr. Hugh Roger and Dr. Gordon M. Jackson in speaking of the work done since organization last April, pointed out that the Hamilton Centre was having

large monthly attendances. This was especially gratifying he pointed out in view of the fact that the society had been in existence only nine months.

The president, in outlining the work for 1931, spoke of the fine support he had received from the officials and council during the past year and said that the council had a concrete programme for the further development of the society in the new year.

Mr. W. S. Mallory then gave the report of the speakers' committee which had functioned so capably during the last year and it was moved by Mr. T. H. Wingham and seconded by Mr. Ptolemy that the financial report of the centre be left to the council because of the temporary absence of the Secretary-Treasurer —Carried.

Mr. T. H. Wingham, B.Sc., then gave a lecture on "How do we Know?" Dealing with the contribution that astronomy had made to the knowledge of science, Mr. Wingham went into the methods used in determining the facts of our solar system. Astronomy is not a science of guess work or conjecture, but deals with facts that are as accurately determined as any branch of mathematics.

Going back to the time of Hipparchus, the lecturer gave a short history of the growth of astronomy and pointed out that in 1668, Sir Isaac Newton showed that light was composed of a number of colours by means of a prism, which indirectly led to the use of the spectroscope. He showed how we may tell by the spectrum of a star whether it is travelling towards us or away from us and how fast. The lecturer also showed how the use of the spectroscope proved the phenomenon of double stars and showed by lantern slides the spectra of such stars of the first magnitude as Capella, Arcturus and Betelgeuse, concluding his lecture with several slides showing the method of photographing sun spots through the various gaseous layers of the sun's photosphere.

January 13, 1931.—The first meeting for the new year was favoured with a large audience.

The president, John A. Marsh, read a communication from the Winnipeg Centre of congratulation on the success of the Hamilton body, after which he gave a short talk on the stars, mentioning some interesting things to be seen during 1931 and the present brilliancy of Jupiter and Mars in the eastern sky.

Dr. Gordon M. Jackson, in outlining the plan of the Programme Committee for the next six months, announced the speaker for the February meeting to be Prof. Findlay on the "Present day theories of the origin of the planetary system", and the lecturer of the March meeting to be Miss Ella J. Reynolds on "Star lore".

Mr. Thos. H. Wingham, B.Sc., was then called upon by the president to introduce the lecturer of the evening, Mr. W. S. Mallory, M.A., a graduate of McMaster University and teacher of Science in the Delta Collegiate. Mr. Mallory then gave an entertaining and instructive lecture on the "Apparent motion of the Sun and Stars in the Heavens", using the lecture hall in planetarium fashion by portraying on the walls the position of the various star constellations, with the sun and moon on the platform, in the form of a globe for the earth and an electric light bulb for the sun.

First outlining the motion of the earth around the sun on its inclined plane and the position of the earth in the various constellations in turn at the spring, summer, autumn and winter seasons, the lecturer then showed, in a very lucid way, the apparent daily westward motion of the sun and the stars. Then he explained the path of the sun eastward among the stars along what is known as the ecliptic. He then explained the celestial pole, the celestial equator and the signs of the zodiac.

His explanation of the charting of the heavens and the terms, "right ascension" and "declination" answered many questions in the minds of the audience regarding the location of any heavenly body. He explained how the planets travelled in the plane of the ecliptic with very little variation in their journey around the sun.

At Ottawa

December 23, 1930—The annual meeting of the Ottawa Centre was held on Friday, December 19, and the following officers were elected for 1931:

Honorary President—C. C. Smith, B.A.
President—J. S. Lane, B.A.
Vice-President—R. Glenn Madill, B.A.
Secretary—Miriam S. Burland, B.A.
Treasurer, A. W. Grant, B.A.
Council—N. A. Irwin, A. H. Miller, A. H. Hawkins, and past presidents, R. M. Stewart, M.A.; R. E. DeLury, Ph.D.; R. J. McDiarmid, Ph.D.; C. R. Coutlee, C.E.

January 30, 1931.—The Ottawa Centre held their opening meeting of 1931, in the Victoria Memorial Museum. Due to illness, the president, Mr. J. S. Lane, was unable to attend and the chair was occupied by Mr. R. Glenn Madill, vice-president.

After welcoming the members and friends, Mr. Madill introduced the speaker, Prof. T. H. Matthews, M.A. (Oxon.), Registrar of McGill University. During the war he was an Instructor-Lieutenant in the Royal Navy, with which he saw active service in the North Sea Fleet; and so he was very well versed in the subject which he chose for his delightful talk, namely, "Navigation and Astronomy".

He started by explaining how the position of a ship may be found at sea, and then spoke of some of the things necessary to be able to carry out this computation; they are chronometer, nautical almanac, mathematical tables, log, compass, and a sextant.

He told how the word "log" originated from a log of wood being thrown overboard at the bow and timed till it reached the stern, later a rope was fastened to this log and knots tied in it, the speed of the ship was then determined by the number of knots which had passed through the sailors' hands as the log travelled the length of the ship, hence the term "knot". Clocks, of course, were not available in those early days and the timing was done by repetition of certain sentences.

To find the position of a ship, it was necessary to be able to get the altitude of the sun, and until some time after Columbus the cross staff was used for this. A somewhat later development was the astrolabe, and now a development of Halley's quadrant is used, namely a sextant.

With the crude instruments of early days, accurate positions could not be found and it was not long before discrepancies were noted in the moon's tables then in use. After much controversy Charles II consented to have new tables made of the moon's position and Flamsteed, the first Astronomer Royal of England, was appointed. With his meagre salary of £100 a year, he had to provide all the instruments necessary for this work. It soon became apparent that a building to house these instruments was necessary and the king issued instructions that an amount of money, not to exceed £500 and to be secured from the sale of bad gunpowder, was to be used for the construction of such a building, and the now famous Greenwich Observatory was built, or rather started.

Advances were also made in methods of measuring time and in 1735 a watch with a compensated regulator was built by Harrison, an English carpenter.

Throughout the evening many interesting slides and also models of some navigating instruments were shown.

MIRIAM S. BURLAND, *Secretary*.

AT VICTORIA

The annual meeting was held on Tuesday, Nov. 25, 1930, at Victoria College.

In the chair, W. E. Harper, M.A., honorary president.

Reports for 1930 were presented by the secretary, the treasurer and the librarian.

Dr. C. S. Beals delivered a lecture on "The Value of Scientific Research."

The election of officers for 1931 resulted as follows:

Honorary President—W. E. Harper, M.A.
President—Dr. C. S. Beals.
First Vice-President—Dr. G. M. Shrum.
Second Vice-President—N. C. Stewart.
Librarian—W. T. Bridge.
Secretary-Treasurer—P. H. Hughes.
Council—J. P. Hibben, R. W. Hunter, Capt. J. H. Hughes, H. Boyd Brydon, T. P. O. Menzies.

January 27.—Dr. C. S. Beals in the chair.

Mr. A. H. Sutherland was elected a member of the Society.

The lecturer for the evening was Dr. G. M. Shrum, of the University of British Columbia, who took as his subject, The Aurora Borealis. Dr. Shrum spoke of the frequency of auroral displays compared with the frequency of sunspots and magnetic disturbances. Many slides from photographs and pictures illustrated the lecture. These showed the display in the form of streamers and draperies but otherwise the display has no definite shape.

At the conclusion of the lecture several members of the audience testified

to having heard the crackling noise accompanying an auroral display in latitudes further north.

It was proposed by Dr. J. A. Pearce and seconded by Mr. H. Boyd Brydon that a committee be appointed to draw up a resolution to come before the next meeting of the Society urging editors of newspapers to discontinue the publication of horoscopes.

February 24.—Dr. C. S. Beals in the chair.

The following were elected to membership:—

R. L. Whitney, Red Deer, Alberta.

Mrs. E. A. Harvey, Victoria, B.C.

The Librarian announced that several books had been added to the library by the gift of Captain John Grice, who is the oldest member of this Centre and who is living at Tofino on the west coast of Vancouver Island.

Dr. J. S. Plaskett, F.R.S., delivered a lecture on Reminiscences of some famous Astronomers. Dr. Plaskett described the happenings at many astronomical gatherings during the last twenty-five years, and gave instructive and entertaining descriptions of his meeting with famous astronomers on this continent and in Europe.

Dr. J. A. Pearce presented the report of a committee appointed to draw up a statement of the attitude of this Centre regarding horoscopes. It was decided to send copies of the report to the editors of local newspapers.

P. H. HUGHES, *Secretary.*

AT WINNIPEG

November 14, 1930.—The regular meeting of the Winnipeg Centre was held in Theatre "A" University Science Building at 8.15 p.m. In the unavoidable absence of the president, Dr. L. A. H. Warren, the vice-president, Dr. N. J. Maclean, occupied the chair.

The first speaker of the evening was Mrs. H. M. Sweet, who gave an interesting account of her visit to the Adler Planetarium last August as follows:

"The word 'planetarium' is used as a name for the instrument, and also for the building which contains the instrument. The building, which is of dark reddish grey granite topped with a copper dome, is situated on an artificial island on the lake front of Chicago. Surrounding the auditorium is a circular corridor, the walls of which are lined with transparencies, showing pictures of eclipses of the sun, sun-spots in various stages, the moon, the planets, spectra of different heavenly bodies, and beneath each picture is the place and date when the observation was made. Here are also many contrivances for showing the relative motions of the earth and other planets, the variation of the pendulum, and models of ancient and modern astronomical instruments.

The auditorium is perfectly round, with the chairs all facing the centre of the circle. Where the black walls join the white dome-like ceiling, the sky-line of the city of Chicago is portrayed. In the centre is the marvellous instrument, which appears, at first sight, like a huge iron dumb-bell, with solid knob-like ends,

and a partly-transparent centre, in which are placed the numerous projectors which throw on the sky-like ceiling, representations of the sun, moon and other heavenly bodies. The instrument takes different positions in response to the manipulations of the lecturer. This is the only planetarium in North America, but one is being manufactured for the city of Philadelphia. There are about twenty in Europe. The firm of Carl Zeiss in Jena is sole manufacturer of the device.

We took our seats, and the auditorium filled rapidly. Suddenly it became dark, and the lecturer, Prof. Morehouse of Drake University, Des Moines, stepped to the rostrum. After explaining the structure of the instrument, by pictures projected on the ceiling, he said we would have a 4-minute day, instead of a 24-hour day. The directions—east, west, north, south—were flashed on the upper walls. A red planet, Mars, rose in the east, followed by Jupiter. A glow spread across the indoor sky announcing the rising of the sun, followed, at intervals, by Mercury and Venus. They rose to the meridian, which was flashed from horizon to zenith in the centre of the southern sky, and in another minute, they sank behind the painted sky-scrapers. Across the sky moved the constellations and planets, as they were moving that night, August 4th-5th, 1930. With a flashlight in the form of an arrow, the speaker traced the outlines of the different constellations as the ancients pictured them. In the northern heavens, the Great Bear, Little Bear and Cassiopeia swung around dizzily in an anti-clock-wise direction. In the southern sky the planets and constellations rose in the east, crossed the meridian, and set in the west.

Then Prof. Morehouse dimmed the sun, and we saw the stars and planets as we would see them in the daytime if the sun were not shining. Next, he took us to the equator. Polaris sank to the northern horizon, and we beheld the skies as seen by the dwellers on the Amazon. A further thrill was ours when the skies rolled from south to north, and we saw the Southern Cross, the false Southern Cross, the Magellan Clouds, Canopus and Alpha Centauri, as they would appear to an observer at the South Pole."

Mrs. E. L. Taylor was the next speaker. Her subject was "The Immensity of the Universe".

Mrs. Taylor commenced by saying that the evening of January 7th, 1610, was a glorious night for astronomy, because on that night, Galileo looked at Jupiter through his new telescope, and began his discoveries in the heavens.

What was then seen, the speaker said, compared as a drop of water to the ocean, with what has since been revealed by the modern telescope. The heavenly bodies fall into two distinct classes; the solar system and the great stellar system. Our solar system is merely our sun with his family of eight—or rather nine—planets. It would take 5800 years for an aeroplane to cross the orbit of the solar system. Speaking of the moon, Mrs. Taylor said that while the moon may appear as the goddess of beauty and a vision of loveliness, it is a monument of desolation when seen through the telescope. It is barren, lifeless and rugged. Its surface is covered with circular depressions called craters. These craters

number about 100,000. There are lofty mountains, including the Appenines. Some of the peaks on these mountains rise to the height of 25,000 feet.

The sun is the most important member of the universe for those who dwell on the earth, from which it is 93,000,000 miles distant. A non-stop aeroplane travelling from the earth at the rate of 200 miles an hour, would reach the sun in 54 years. It would require 1,300,000 earths such as ours to make our sun. Compared with another immense sun, Antares, which has a diameter of 400,000,000 miles and is 75,000,000 times larger in volume, our sun is small.

Speaking of Alpha Centauri, the nearest star, Mrs. Taylor mentioned that it was 25,000,000,000,000 miles away. If a bullet could be fired from the earth, it would require 2,000,000 years to reach this nearest star. A non-stop aeroplane travelling at the rate of 125 miles an hour, would take 20,000,000 years to reach the nearest star.

The telescope has revealed many millions of stars in the Milky Way. They are as snowflakes, denser than the worst blizzard ever seen in Manitoba. Yet every flake is of a tremendous sun, of which probably no two are closer than one million miles.

Quoting Jeans as authority, Mrs. Taylor said that the suns in the sky outnumbered the specks of dust in the city of London, England.

S. C. NORRIS, *Secretary*.

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The Astronomical and Physical Society of Toronto was incorporated in 1890, though it had existed some years before this; in 1900 it became The Toronto Astronomical Society; and on March 3, 1903, it was given permission to use the name, The Royal Astronomical Society of Canada.

Its objects are to study astronomy and cognate subjects, to publish the results of its work, and to maintain a library.

For many years the Toronto organization existed alone, but now the Society is national in extent, having active Centres in Montreal, P.Q.; Ottawa, Toronto, Hamilton and London, Ont.; Winnipeg, Man.; and Victoria, B.C. Among its 800 members are a number of leading astronomers and scientists of the world, many amateurs, and, in addition, many laymen who are interested in the culture of the science.

The Society publishes a monthly JOURNAL containing each year about 500 pages of interesting articles and a yearly OBSERVER'S HANDBOOK of about 80 pages, containing valuable information for the amateur observer. Single copies of the JOURNAL or HANDBOOK are 25 cents.

Membership in the Society is open to anyone interested in astronomy. Annual dues, $2.00; life membership, $25.00 (no further dues). Publications are free to the members, or may be subscribed for separately.

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The library and offices of the Society are at 198 College St., Toronto, Ont. Applications for membership or for further information should be addressed to a local secretary (see back of this page) or to the General Secretary at the above address.